Changes in abundance of silver perch and cunner in relation to increasing sea surface temperature in the Mullica River–Great Bay Estuary, NJ

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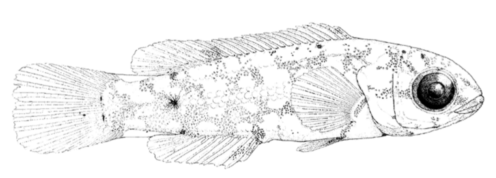
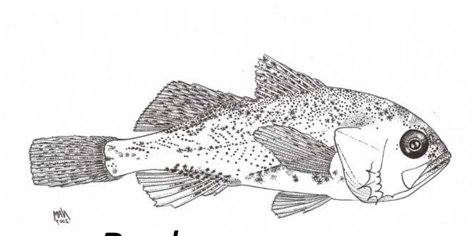
Introduction

The Mullica River–Great Bay Estuary, (MRGB) is a temperate, lagoonal estuary in southern New Jersey. Rising water temperature due to climate change is expected to alter the species distribution and relative abundance and length of fishes recruiting in estuaries such as the MR–GB . Patterns of American Silver Perch (*Baidiella chrysoura)*, a southern Atlantic species and Cunner (*Tautogolabrus adspersus)*, a northern Atlantic species, were examined to test this response.



T. adspersus



B. chrysoura

B. chrysoura is a migratory species with a range distribution from the Chesapeake Bay to the Hudson River and can be found as far north as the Connecticut River. *T. adspersus* is a resident species of the MR–GB Estuary with a range distribution from Newfoundland, Canada to the Delaware Bay and can be found as far south as the Chesapeake Bay.

Our primary research questions:

1. Is abundance of the northern species (*T. adspersus*) decreasing, while abundance of the southern species (*B. chrysoura*) increasing due to increasing sea surface temperatures?
2. Are average lengths of *T. adspersus* and *B. chrysoura* changing over time?

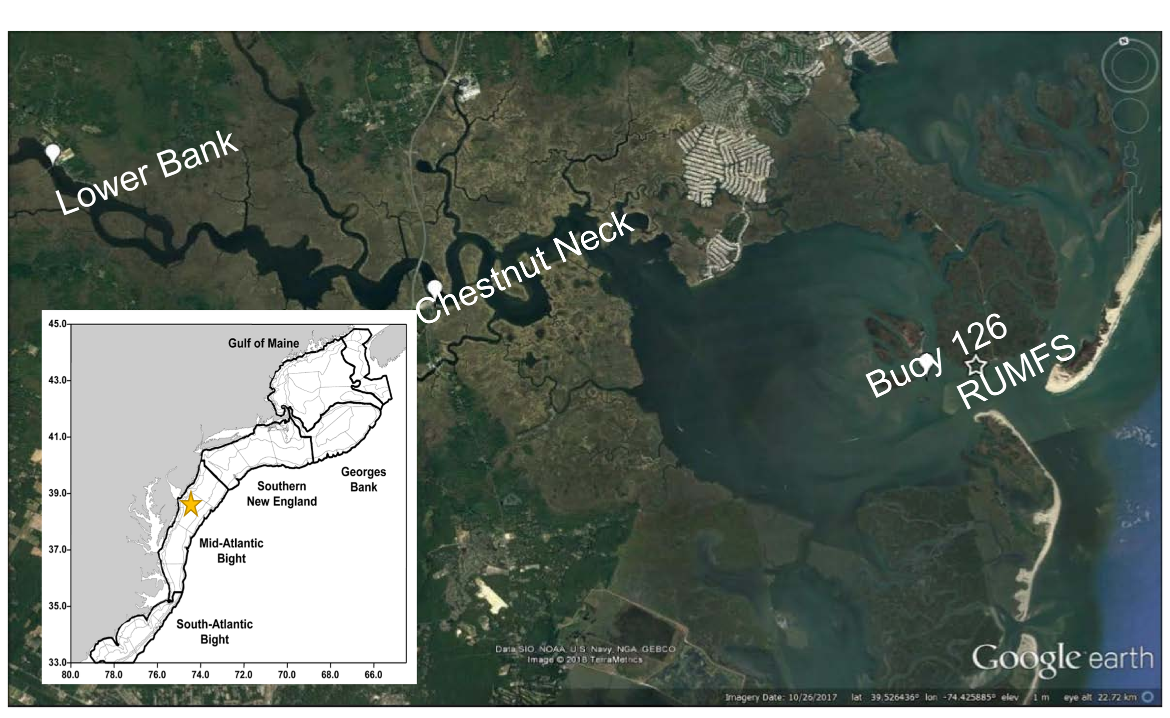


Figure 1. Map of the study area, the Mullica River–Great Bay Estuary. JCNERR collected temperature data from Lower Bank, Chestnut Neck and Buoy 126. *B. chrysoura* and *T.* adspersus were obtained from RUMFS.

Methods

Temperature data were collected within Jacques Cousteau National Estuarine Research Reserve (JCNERRS; https://jcnerr.org/) at three locations in the MR–GB Estuary (Fig. 1). The data were taken near the sea surface every 30 minutes for 20 years (1996 – 2016). These data were combined with monthly mean temperature data at Rutgers University Marine Field Station (RUMFS) to extend the time series to 1990. Linear regression was performed to determine the trend in annual average temperature for each location. The significance of the trends were tested with a slope regression test.

Abundance and length data of YOY *T. adspersus* and *B. chrysoura* were obtained from RUMFS by Gee minnow traps (N=6 on average) twice weekly between 1993 – 2017. Abundance data were normalized by the number of traps for count per unit effort. Data were averaged from the months of July, August, and September, when both species are typically present in the estuary.

Results

Statistically significant warming trends were found at multiple sites throughout the MR-GB Estuary. For example, annual SST significantly increased between 1990 and 2017 at RUMFS ($p<0.05$, slope regression test). Interannual variability of annual temperatures was ±1°C (Fig. 2).

Average abundance of *T. adspersus* decreased over time at a statistically significant rate (Fig. 3). There was a weak correlation between abundance and interannual temperature variability.

Abundance of *B. chrysoura* was much higher than normal in four years of the time series (Fig. 4). There was not a significant trend in abundance over time when these high abundance years were excluded.

Mean length of *T. adspersus* had a positive trend over time and *B. chrysoura* mean length did not have a statistically significant trend (Fig. 5).

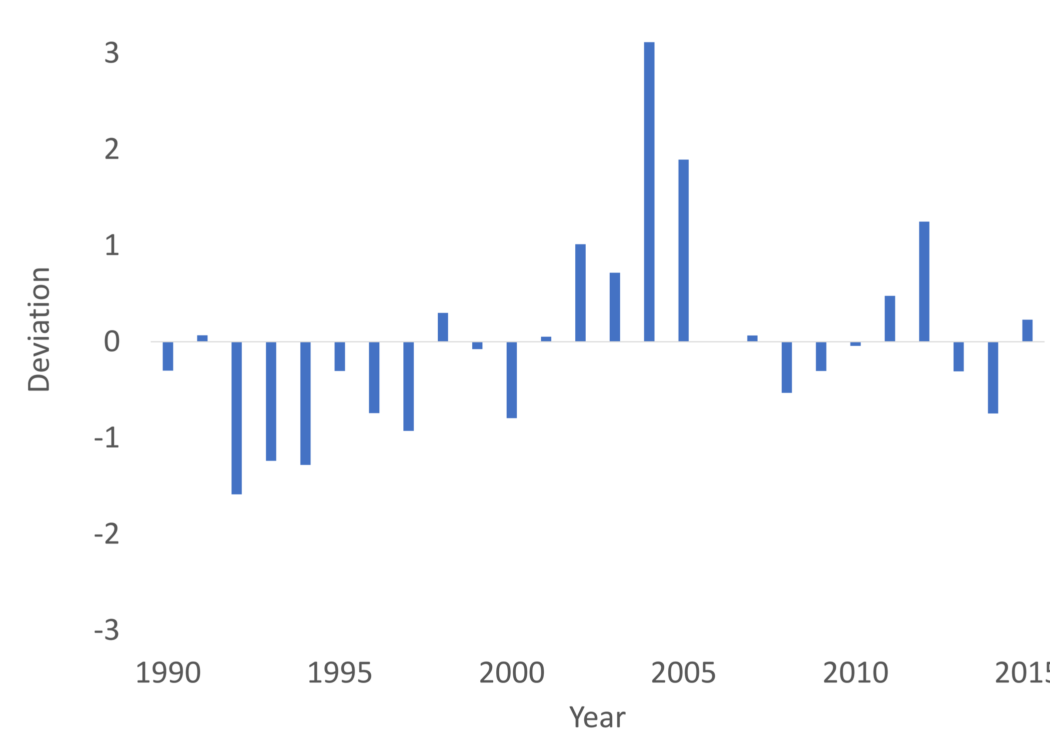


Figure 2. Annual temperature anomalies calculated by subtracting the 1990-2017 linear trend from each year's average water temperature.

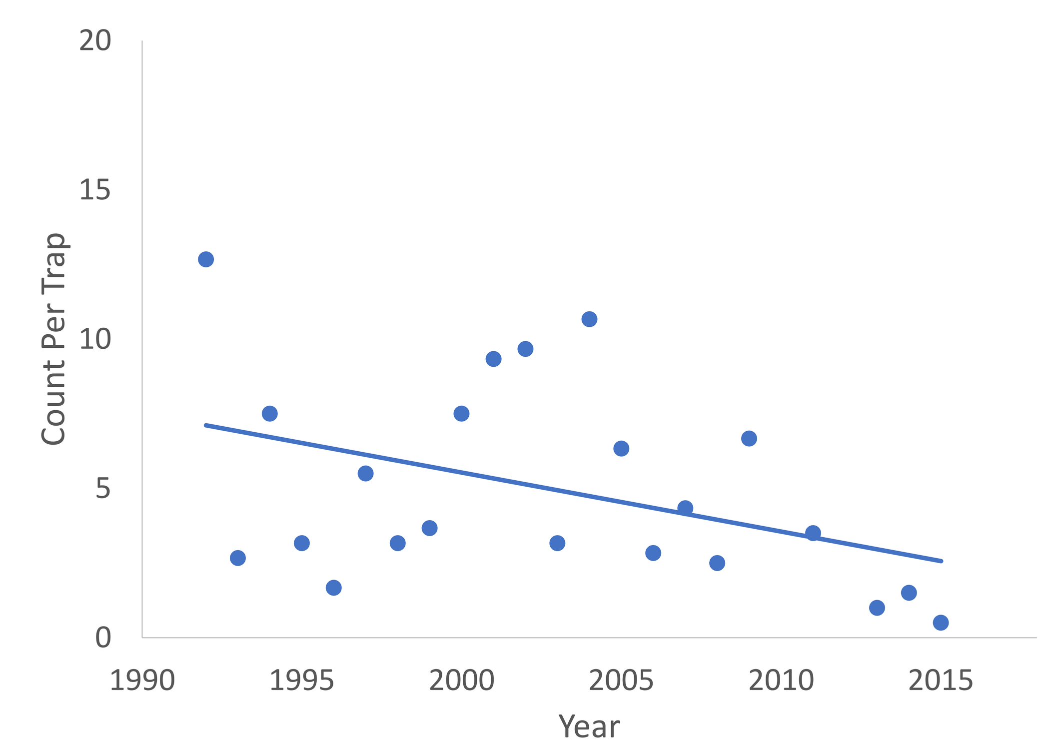


Figure 3. Average count per trap of *T. adspersus* from 1992 – 2015. Linear trend has a statistically significant slope of –0.2 per year.

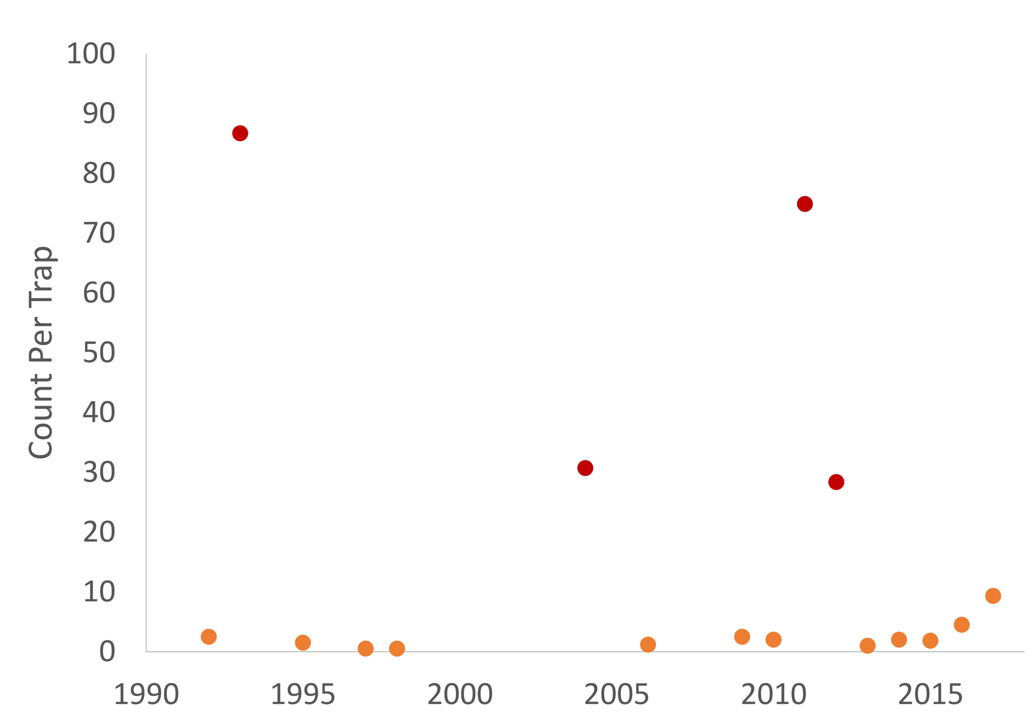


Figure 4. Average count per trap of *B. chrysoura* from 1992 – 2017. Four years of high abundance are highlighted in dark red.

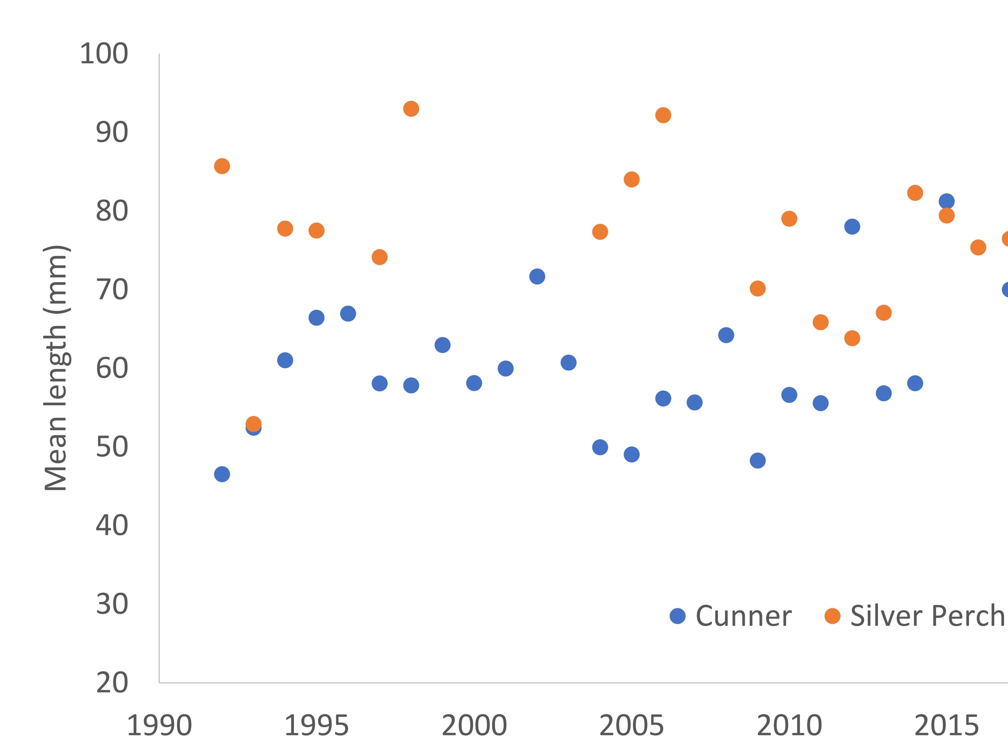


Figure 5. Average length of *T. adspersus* and *B. chrysoura* from 2004 – 2017 in the months of July, August and September.

Conclusions

Average annual water temperature from 1990 – 2016 at RUMFS reveal that sea surface temperatures are rising at a significant rate in the MR–GB estuary.

The abundance of the resident species *T. adspersus* decreased at a significant rate. It also found that the length of *T. adspersus* increased over time.

Changes in the abundance of the migratory species *B. chrysoura* was not conclusively connected to local temperature during the species' spawning months. Migratory patterns of *B. chrysoura,* along with other factors might highly affect the abundance of the species found in the MR–GB Estuary.

High interannual variability in both temperature and early life stages of fish point to the need for continuing long term data series of *T. adspersus* and *B. chrysoura* in the MR–GB Estuary to assess effects of warming ocean temperatures on fishes that reside in or migrate to Mid-Atlantic estuarine habitats.

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